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## Welded Steel Pipe Design

**Course Number:** ME-02-341

**PDH:** 8

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After the course has been purchased, review the technical material and then complete the quiz at your convenience.

A Certificate of Completion is available once you pass the exam (70% or greater).

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## Module 1: Welded Steel Pipe

### Learning Objectives

By the end of this section, you will be able to:

- **Identify** the seven core performance requirements for buried flexible pipelines.
- **Evaluate** the scope of design criteria applicable to large-diameter welded steel pipe systems.

*Executive Summary:* Modern welded steel pipe design leverages advancements in cold-forming and automated spiral welding to provide a highly versatile, economical solution for large-scale infrastructure, meeting rigorous standards for strength and service life in buried applications.

### Design Fundamentals

Welded steel pipe has undergone significant technical evolution throughout the 20th century, specifically regarding production economy and material quality. Current manufacturing utilizes sophisticated machines for the **cold-forming** of flexible pipe from sheet steel coils, integrated with **automated spiral welds**.

Recent engineering strides have focused on:

- **Quality control** and rigorous testing protocols.
- Development of advanced **joint systems**.
- Specialized **protective coatings** to enhance durability.

### System Scope

Welded steel pipe is available in an extensive range of sizes and mechanical steel properties. This module addresses design criteria for pipe diameters up to **240 inches (6,000 mm)**, covering performance under both **internal and external pressure** conditions.

### Core Requirements for Buried Flexible Pipe

The successful implementation of a buried flexible pipeline depends on meeting seven fundamental criteria. The inherent properties of steel are uniquely adapted to satisfy these engineering requirements:

1. **Strength:** Ability to resist internal and external loading.
2. **Ease of Installation:** Lightweight characteristics and ring stiffness for handling.
3. **High Flow Capacity:** Low frictional resistance and smooth linings.
4. **Leak Resistance:** Utilization of bottle-tight welded or gasketed joints.
5. **Long Service Life:** Durability through corrosion control and coatings.
6. **Reliability and Versatility:** Ductility to handle unanticipated loads and ease of field modification.
7. **Economy:** Cost-effectiveness across the entire design life.

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*Checkpoint Quiz*

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**1. What is the maximum pipe diameter covered by the design criteria in this manual?**

- a) 120 inches
- b) 180 inches
- c) 240 inches
- d) 300 inches

**Answer:** (c). The manual explicitly states its scope covers design criteria for steel pipe diameters up to 240 inches (6,000 mm) for both internal and external pressure applications.

**2. Which manufacturing process is noted for creating flexible pipe from coils of sheet steel?**

- a) Hot-rolling with longitudinal seams
- b) Cold-forming with automated spiral welds
- c) Centrifugal casting
- d) Forging

**Answer:** (b). This advanced technological process allows for the economical production of flexible pipe by shaping steel coils into a cylinder joined with continuous spiral welding.

**3. According to the text, why are the properties of steel well-suited for buried pipelines?**

- a) Because steel is a brittle material
- b) Because it is only available in small diameters
- c) Because it adapts to the seven core requirements of buried pipe
- d) Because it requires no protective coatings

**Answer:** (c). Steel possesses the inherent strength, ductility, and reliability necessary to satisfy all seven performance criteria—including leak resistance and ease of installation—required for buried service.

## Module 2: Research and Development

### Learning Objectives

By the end of this section, you will be able to:

- **Identify** the key industry organizations responsible for developing steel piping standards and certification programs.
- **Evaluate** the role of industry-led research in advancing metallurgy, welding technology, and protective systems.

*Executive Summary:* The continuous advancement of steel pipe technology is driven by rigorous research and development facilitated by the Steel Tank Institute/Steel Plate Fabricators Association (STI/SPFA) and the American Iron and Steel Institute (AISI). These organizations ensure quality, safety, and innovation in the manufacture and operation of steel pipelines through the collaboration of producers and pre-eminent engineers.

### Industry Standards and Certification

The **STI/SPFA**, which consists of the Steel Tank Institute and Steel Plate Fabricators Association, has been a cornerstone for the water, food, petroleum, and chemical markets since 1916. The organization focuses on creating high-level benchmarks for the industry:

- **Developers of standards** and certification programs for quality and safety.
- **Ensure reliability** in the manufacture, installation, and testing of steel tanks, piping, and pressure vessels.
- **Engagement in national committees** to prepare codes and specifications for the design and operation of steel infrastructure.

### Collaborative Research Initiatives

Research and development are collaborative efforts between North American producers and pipeline engineers. These partnerships maintain facilities dedicated to several critical technical areas:

- **Metallurgy and Welding:** Studying the core properties and joining methods of steel.
- **Joints and Protective Systems:** Researching pipe linings and coatings to extend service life.
- **Manufacturing Processes:** Ongoing study of new product developments and process improvements.

### Market Development and Advocacy

The **American Iron and Steel Institute (AISI)** represents approximately 75% of North American steel capacity and serves as the primary industry voice in public policy.

- **Technological Leadership:** AISI plays a lead role in the development of new steels and steel-making technologies.
- **Market-Driven Strategy:** Promoting cost-effective, steel-based solutions specifically for the construction, automotive, and container markets.

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*Checkpoint Quiz*

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**1. Which organization represents approximately 75% of the U.S. and North American steel capacity?**

- a) STI/SPFA
- b) USACE
- c) AISI
- d) ASCE

**Answer:** (c). The American Iron and Steel Institute (AISI) serves as the primary voice of the industry, with member companies accounting for roughly three-quarters of North American steel production capacity

**2. What technical areas are specifically cited as focal points for STI/SPFA research facilities?**

- a) Excavation and trenching safety
- b) Metallurgy, welding, joints, and coatings
- c) Hydraulic modeling and fluid dynamics
- d) Environmental impact assessments

**Answer:** (b). The STI/SPFA and its members specifically sponsor and maintain research facilities dedicated to advancing the science of metallurgy, joining techniques, and protective lining or coating systems.

**3. Since what year has the STI/SPFA served as a developer of standards for quality and safety?**

- a) 1855
- b) 1916
- c) 1941
- d) 1950

**Answer:** (b). The organization has a legacy spanning over a century, having served the water, petroleum, and chemical markets through its certification and standards programs since 1916.



## Module 3: History of Steel Pipe

### Learning Objectives

By the end of this section, you will be able to:

- **Trace** the four major technological evolutionary stages of iron and steel pipe manufacturing.
- **Evaluate** the mechanical properties of steel, specifically toughness and ductility, as they relate to buried pipeline performance.
- **Select** appropriate ASTM steel grades based on minimum yield and tensile strength requirements for specific design pressures.

*Executive Summary:* The evolution of water transportation—from ancient bamboo and tile to modern welded steel—highlights a continuous search for strength, durability, and hydraulic efficiency. Today’s steel pipe offers unparalleled reliability due to its high ductility (25% strain limit) and a wide range of standardized ASTM grades that allow for optimized, cost-effective design.

### The Evolution of Strength and Durability

The transition from primitive materials to modern steel occurred through four pivotal technological advancements:

1. **Early Iron Pipe (1824–1830):** Following inventions by James Russell (welding iron tubes) and Cornelius Whitehouse (bell-shaped die drawing), the first U.S. wrought iron pipe furnace was built in 1830 to meet the water demands of growing cities.
2. **The Age of Steel (1855–1861):** Sir Henry Bessemer's patent (1855) and the development of the open-hearth furnace (1861) made steel available in mass quantities. This allowed for cold-forming sheets into various diameters, initially using longitudinal riveted seams.
3. **Lock-Bar Steel Pipe (1905):** This method utilized H-shaped longitudinal bars to clamp semi-circular pipe halves under 350 tons of pressure. It achieved 100% seam efficiency and increased carrying capacity by 15% to 20% compared to riveted pipe.
4. **Automatic Electric Welding (1920–Present):** Moving from a novelty in the 1920s to a standard during WWII, welding technology transitioned to straight-seam electrical resistance, fusion welding, and spiral fusion welding, ushering in the era of large-diameter, high-pressure pipelines.



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